Supplying Sugar Creek

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Pyroprocessing specialists, A TEC GmbH, describe the work undertaken during Lafarge Sugar Creek's installation of a new bypass system. An overview of the project scope, its execution and performance results are presented, plus details of A TEC's new and unique smelting dust system.


Lafarge Sugar Creek

The Sugar Creek plant was built by the Lafarge Group in 2002. It is one of the flagship plants of Lafarge North America. Clinker production is 946,000t with a five-stage precalciner tower and a 50m x 4m kiln. This is eight per cent over nominal plant design.

Project background

Even before the plant started, rock samples taken from limestone reserves had shown that chlorine would be a concern. After months of operation following start-up of the plant a clear relationship among sulphur, chlorine, and buildup within the preheater tower was evident. Chlorine was accumulating in the system, within stages four and five. The only method found to resolve the problem was to replace some of the St Louis formation limestone (mined underground) with purchased Bethany formation limestone (which contained about half of the chloride content of St Louis). The use of Bethany limestone, while necessary to achieve stable kiln operation with no bypass, resulted in a higher operating cost.

Fuels are the other main source of chlorine inputs. To control these input levels all coal is purchased with a specification for low chlorine content. Following start-up, the plant made several attempts to utilise petcoke as a fuel source. But high quantities of sulphur in the petcoke tended to increase the chlorine volatilisation, resulting in fifth stage cyclone plugging and kiln shut-downs.

All this considered, an installation of a bypass system was decided to allow the Sugar Creek plant to achieve the following:

- create a safe working environment by eliminating the need to stimulate flow from within the preheater tower
- allow reductions in the raw material and fuel costs for the plant
- maintain stable kiln operation and product quality while achieving the best possible overall EVA.

Selection of the process

Lafarge CTS selected a conventional extraction system and dry cooling process to cool the bypass gases due to its experience with such designs.

Main project partners

Lafarge CTS in Montreal and the plant engineered the overall bypass system.

A TEC GmbH (formerly known as PMT-Zyklontechnik GmbH) designed the quenching system including the take-off duct, the quenching chamber, the related fans and insulation as well as the gates

Figure 2: quenching chamber

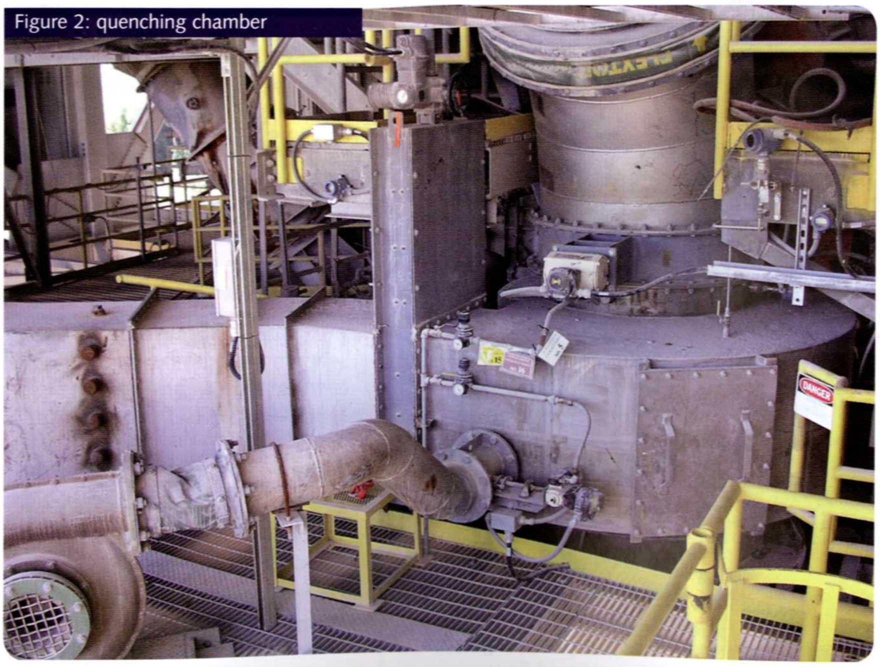

Table 1a: chemical analysis

	Kiln feed	Recirc. dust	Raw mix	Kiln load	Clinker
Flow (mt/hr)	181.42	15.57	165.85		110.00
LOI (%)	35.00	35.00	35.00	3.50	0.50
SO_3 (%)	0.73	0.45	0.76	0.90	0.45
K_2O (%)	0.53	0.21	0.56	1.91	0.49
Na_2O (%)	0.67	0.29	0.71	0.55	0.61
Cl (%)	0.037	0.095	0.031	0.769	0.028

Table 1b: fuel analysis

	Coal	Coke
LHV (MJ/mt)	27.05	32.81
Ash (%)	11.46	0.16
S (%)	0.58	4.08
K_2O (%)	1.24	0.00
Na_2O	0.92	0.00
Cl	0.002	0.070

Table 1c: bypass data

Bypass Gas	*5326Nm³/hr at 1112°C*
Kiln load SO_3 (%)	0.90
Kiln load K_2O (%)	1.91
Kiln load Na_2O (%)	0.55
Kiln load Cl (%)	0.769

and dampers. The quenching chamber was also supplied by A TEC GmbH.

Solios Environment of Montreal supplied the baghouse system and Howden Buffalo supplied the fans. Irondale Industrial Contractors of Birmingham Alabama provided the erection.

Design requirements and parameters

The bypass system starts at the existing gas take-off flange above the kiln inlet and ends at the penetration into the raw mill inlet duct for the gas flow. It includes a system to cool down the collected high-chlorine dust before it is loaded into trucks for disposal.

The bypass system takes off kiln gases from an existing flanged outlet 900 wide x 1500 high in the kiln riser duct.

Complete mass balances help Lafarge to define the bypass requirements. The bypass is designed for 10 per cent of the kiln gas flow rate or: 5326Nm^3/h at 1112°C. It allows the kiln to master the volatile load at the kiln inlet and to run the kiln in a very stable manner.

The quenching chamber air discharge temperature is to be maintained at 180°C based on 35°C ambient air.

Quenching chamber

The A TEC GmbH quenching chamber is unique, in that it is very compact and doesn't require any refractory. The fresh air spirals around the core of the chamber where the hot gases flow and then both are mixed very quickly. The ability to quench the hot gases almost instantaneously comes from A TEC GmbH extensive experience in designing high efficiency and low pressure drop cyclones.

The existing structural arrangement of the precalciner tower was such that the take-off chamber and duct going to the quenching chamber was close to a large structural beam. Should the take-off duct go above, below, or even be split with a portion above and a portion below. In addition to its dimensions, the angle of the take-off duct is critical to capture the right amount and particulate size distribution of the dust in the gas.

Another unique feature is that the

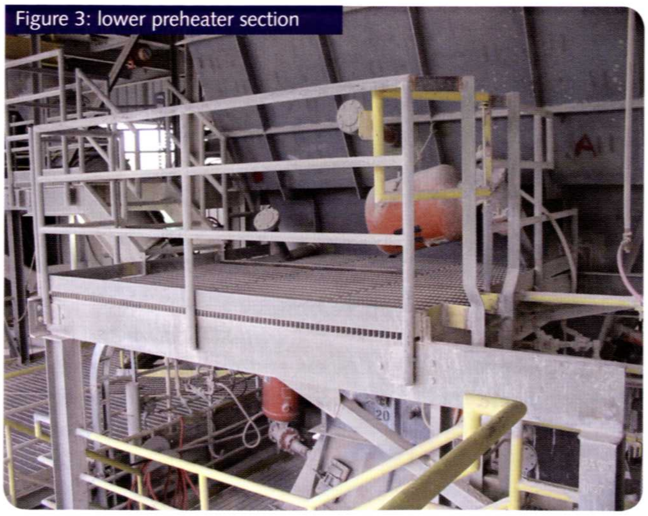

Figure 3: lower preheater section

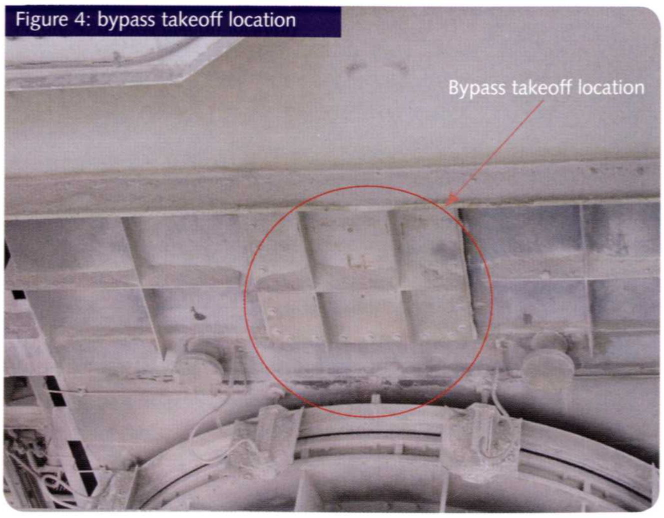

Figure 4: bypass takeoff location

Figure 5: front view of the preheater

plant wanted to have a large range of bypass ratio. Therefore, A TEC GmbH designed the quenching chamber with two compartments, one being used for lower bypass flow and both being used at higher flow. It is like having two smaller chambers arranged in parallel.

Commissioning took place in August 2005 and performance testing took place in October 2005 .

Because the achieved rate of the dust quantity is higher than expected, Lafarge North America Inc confirmed and approved the fulfilment of the contract and performance guarantees.

This high kiln back-end dust loading results in a somewhat diluted bypass dust, as shown by the analysis in Table 2.

Conclusion & next steps

Although the 10 per cent value was not reached due to a slight undersizing of the cooling fan, the 8.3 per cent reached actually draw a lot more bypass, the chlorine reduction in the hot meal is higher then expected and the plant has to operate on only a bypass rate of three per cent; there is no clogging of the take-off chamber nor the preheater. Lafarge is satisfied with the performance of the bypass system and has signed the certificate of completion.

Now that the bypass dust is collected, one issue facing the plant is what to do with the heavily charged dust. The cement industry as a whole is facing that problem. A small amount can be mixed with clinker within the limit of the regulations, some can be sold as soil stabiliser if there is a market for it – the rest must be land filled at an estimated cost of approximately US$7/st.

A TEC GmbH has developed a unique smelting dust system called SYNSLAG® that processes and renders inert the dust so that it can be used as slag and completely mixed with clinker.

The bypass dust is mixed with a silica source (eg sand) to control the pH to a level of 1.4 to 1.6 to improve the smelting properties of the material.

The material is molten in the Tribovent flash-smelting unit under oxidising conditions. The synthetic slag produced is downgraded in its chlorine content and can be used as a cementitious additive to cement. Quenching or granulation are further possible process steps.

The flue gas of the Tribovent flash-smelting unit contains the evaporated salt compounds beside some residual dust from the smelting process. The gas treatment can be done two ways:

- to condense a solid salt product mainly consisting of K_2SO_4 and KCl; by cooling it down and cleaning it. Further treatment of the flue gas might be necessary.
- to generate hydrochloric acid using a wet-scrubber.

Figure 6: A TEC's new SYNSLAG® smelting dust system

Table 2: high kiln back-end dust loading results

SiO_2	*Al_2O_3*	*Fe_2O_3*	*CaO*	*MgO*	*SO_3*	*Na_2O*	*K_2O*	*Cl*	*LOI*	*Total*
15.99	4.118	2.063	59.35	1.10	3.22	0.761	4.64	2.53	5.36	98.99